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A Proposed Conceptual Design for a Computer-Based Ambulance System in Libya Using IoT

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Abstract: Due to the increase in the world's population which increased road congestion, the ambulances that carry patients have so many difficulties in getting to the hospital before the patient's condition gets worse. The problem of the delayed arrival of the patient to the hospital was found globally in most countries. Especially in Libya, the problem is more complex, the ambulance services are weak, patients face problems in getting fresh blood packages, and the health system lacks an electronic health record. In this paper, a descriptive comparison is conducted to evaluate, compare, and analyze different proposed solutions. Then, a new different solution is proposed. To check the feasibility of the newly proposed solution, a survey was conducted to review the audience's level of satisfaction with the traditional ambulance services, as well as the proposed solution, the results showed the people's lack of trust in the current ambulance services, and their reluctance to rely on the service. However, the results also revealed the people's acceptance of the proposed solution, and their willingness to rely on it.

Keywords: Ambulance system, Healthcare system, IoT.

Introduction

Using modern technology in healthcare is popular these days and using technology to ensure patient well-being is attainable (Salau et al., 2020). In today's systems, advanced healthcare applications are required. As the world's population and technologies increase at exponential rates, so do the number of accidents and medical issues. In the medical area, several sorts of smart technologies have become a requirement (Dumka & Sah, 2019). Technology automates and extends activities that formerly required human intervention, allowing medical staff to focus their time and energy elsewhere, while potentially lowering total healthcare costs Scherman, 2019.). Information technology IT has become more important in the healthcare industry to ensure that medical and administrative operations function efficiently. Whether it's for workplace automation or to reduce medical errors, IT can help (Bernstein et al., 2007). By integrating medical devices, automating financial transactions, and eliminating errors, advances in information communications technology have the potential to alter the traditional healthcare system and increase consumer confidence in the system. Furthermore, as the need for ambulance services rises, many hospitals are finding it difficult to achieve response time goals. Although ambulance services normally perform both emergency response and patient transfer on behalf of the health sector, their primary job is to provide emergency pre-hospital medical care. In recent years, it has become clear

that expanding healthcare system challenges cannot be overcome solely by additional resources; they also require new service delivery methods and techniques. Ambulance services can impact the success of health initiatives by integrating them into health systems in general, and by employing modern technologies to increase efficiency.

As a result, one of the key difficulties causing severity for a patient is a delay in travel time. Because of the delay in getting to the hospital, the doctor will not be able to treat the patient right away, and the preparation for treatment will begin only after the doctor has assessed the patient's health situation. This delay may put patients in jeopardy and, in some cases, lead to death. This paper proposes a conceptual design of an integrated and upgraded ambulance management system for Libya, connected to the main hospital, automates the process of admission, and enables remote treatment by increasing the awareness of the patient's current state.

Literature Review

The proposed ambulance system shared goals with several of the initiatives that offered various solutions. Smart city applications, IoT, 5G, and smart health systems were among the general subjects investigated.

The Use of Modern Technologies in Improving Health Care Systems

Modern technologies can be used to develop these emergency medical systems. The argument that 5G wireless technology, together with related developing technologies (such as Internet of Things IoT, big data, artificial intelligence, and machine learning), will change global healthcare systems soon (Latif et al., 2017). It was found that with the (IoT) rapidly emerging as the next phase of the Internet's growth, it's becoming increasingly important to recognize the many potential fields for IoT applications (Albayood et al., 2020). Therefore, the Internet of Things is paving the way for new types of research to be conducted (Nath Saha, 2020).

A review of recent works, presented a comprehensive overview of network layer solutions for IoT-based 5G smart healthcare, including scheduling, routing, and congestion control, that covered both recent work and future research opportunities. Finally, the open issues and challenges for future 5G smart healthcare were briefly discussed (Ahad et al., 2019). Another paper identifies current trends, applications, and procedures in healthcare data analytics and health informatics with decision support systems so that healthcare specialists, researchers, and analysts can have a better knowledge of their clinical applications (Godbole & Agarwal, 2020). The design and execution of a smart health monitoring system of leveraging cutting-edge technology, such as the IOT have been demonstrated by Vippalapalli and Ananthula. A patient can be monitored utilizing a set of lightweight wearable sensor nodes that allow for real-time sensing and analysis of numerous vital indicators (Kalarthi, 2016; Vippalapalli & Ananthula, 2016).

A report published in 2020 advocated the construction of a smart healthcare system that would use artificial intelligence to solve difficulties in the healthcare business and optimize patient care plans. It claimed that the suggested architecture can deal with a wide range of complex healthcare issues and may be implemented in any modern hospital to save time and money. This paper also demonstrates the current growth of AI applications in healthcare, which might be applied in the architecture described (Kamruzzaman, 2020). A framework for e-Health and m-Health that uses smartphone sensors and body sensors to acquire, process, and transfer patient health data to the cloud for storage is proposed by (Ullah et al., 2016). The suggested architecture, dubbed k-Healthcare, is made up of four layers that work together to enable effective data storage, processing, and retrieval (A. Al-Tawaty & Omar Elfallah, 2019).

Upgrading the Ambulance Services by the Integration of Modern Technologies

I. S. Sherly and M. A. Sobitham Princy have proposed a solution based on the Internet of Things. They are connecting the ambulance to the IoT, which includes biomedical sensors such as heartbeat rate sensors, temperature sensors, and ECG sensors that will sense and detect the injured person's health conditions and send the information to the hospital server. This proposed device is being developed to avoid lateral hospital arrangements (Sherly & Sobitham Princy, 2019). Another research on 2019, comprises an ambulance outfitted with wireless body area network (WBAN) sensors that detect real-time patient data. IoT data aggregation is used to deliver aggregate real-time data to clinicians at remote hospitals, and these sensors communicate data to the

center node or sink node via the Message Queuing Telemetry Transport (MQTT) protocol (Dumka & Sah, 2019).

A smart ambulance management system in a smart city in Turkey implemented which if a patient requires an ambulance, the system instructs the operator to locate the closest ambulance and send it to the patient. The system dynamically tracks ambulance locations, and Google Maps is utilized to compute the quickest way to the victim as a third-party service. Following contact with the patient, the expert (doctor or nurse) evaluates the issue and, using the suggested approach, locates the best available hospital (Akca et al., 2020). Another smart system was created to warn other cars of the ambulance's approach by making the ambulance's position information available. The suggested approach involves just installing a smartphone-based special application on a dashboard to turn an ambulance into an IoT device (Kobayashi et al., 2019).

The Smart Ambulance Traffic Control System was proposed in (Krishnan et al., 2021). It is a traffic light control system that is incorporated for emergency ambulance service. When an emergency ambulance approaches, the traffic lights can be controlled in a timely and efficient manner. During traffic congestion, Radio-Frequency Identification (RFID) is used as a tool to communicate with traffic lights. The emergency ambulance driver must activate the RFID tag for RFID readers to be detected and for traffic light operation to be controlled at upcoming traffic light junctions. The traffic lights in the path of the ambulance are forced to be green to allow the emergency ambulance to pass through the junction with top priority. The control system will reset and return to normal operations as soon as the ambulance passes through the intersection.

Another paper from Malaysia described a useful 5G health use case for transmitting medical ultrasound video streams in the uplink direction between a moving ambulance and a hospital. This use case is critical because the patient is most vulnerable and requires immediate attention. Furthermore, using ultrasound video streaming as an example of a critical m-health application, this article explored the feasibility of implementing mobile small cell networks in an m-health context (Rehman et al., 2018). The issues that emergency service providers face on the road network are discussed in this (Pasha, 2016) master thesis. A prototype system based on GIS, GPS, and GSM was developed for ambulance routing on Hyderabad's road network (Ambulance management system (AMS)). Using real-time technologies (GPS/GSM), this prototype locates an accident on the road network and locates the closest ambulance to the incident site. GIS users assessed this ambulance management system, which was designed utilizing a software engineering model rapid prototyping technique (Pasha, 2016).

This review (U, N, Aithal, Shripad Bhat, & K (2019)) offered an application called HPVB (High Priority Vehicle Booking), in which the user may book an ambulance with a single touch and monitor it using GPS on his mobile. A microcontroller-based hardware module was also utilized to enable a smooth flow for the ambulance to reach the desired destination. This is accomplished using 3RFID technology, which automatically controls traffic lights along the ambulance's path, reducing the time it takes to get to its destination. In other hand, research published in 2020, an RFID-based traffic management system was presented. Using this technology, traffic lights at intersections can be controlled and regulated when emergency vehicles approach. As a result, emergency vehicles will be able to travel through traffic with ease. An experimental setup employing Arduino and LED displays is used to model the suggested framework, which replicates a real-time traffic scenario. The simulation results show the parameters of detection as well as giving passage for the emergency vehicle during peak hours to avoid delays. The research claims that with this technology, emergency vehicles are less congested and arrive at their destinations faster (Girish et al., 2020).

Fong et al. (2018) proposed a smart ambulance system that consists of a network of connected medical devices, sensors, and wearable assistive devices worn by paramedics, as well as consumer health devices worn by patients. An IoT platform acts as a link between paramedics and patients, as well as the hospital network, providing assistance ranging from patient medical history retrieval to receiving remote support for on-scene treatment. It mentioned that wearable sensors are critical components of an IoT ecosystem that allows for continuous monitoring of a patient's health, giving paramedics a far more complete image of the patient than standard emergency medical techniques can provide (Fong et al., 2018).

Live monitoring system based on the Internet of Things was proposed for patients in danger of heart attack and having an inconsistent body temperature. A live trafficking system was also created, which uses Google Maps to ensure that the ambulance arrives on time. The research goal was to create an intelligent smart health system using sensors and microcontrollers that can sense the body's state and communicate the information to a collaborative hospital's website (Saha et al., 2017). Besides, A. G. Karkar presented a smart ambulance system that considers highlighted emergency routes. The solution is a set of smart healthcare emergency apps aimed at improving ambulance infrastructure. Its goal is to keep drivers informed about the emergency routes that

ambulances use. The suggested system consists of three parts: a server program, a user emergency end-user application, and a paramedic end-user application. Paramedics determined that the suggested approach would improve patient transportation time to hospitals based on an initial assessment utilizing questionnaires (Karkar, 2019).

Another research published in 2015 presented an E-Ambulance system, which is a smart ambulance model that enables auto-reaction activities as well as monitoring to improve the chances of saving patients from life-threatening situations. To accomplish this purpose, biosensors, actuators, intelligent units, GPS, and other components and technologies were employed. The Data Distribution Service (DDS) model is utilized to link these disparate components of the system. As a result, they assessed the latency and throughput performance metrics of wireless communication between a set of nodes using various QoS profiles. DDS demonstrated great performance in general and met medical standards for transmitting monitoring data within defined limits (Almadani et al., 2015).

A traffic controlling/movement system was proposed in a study conducted in 2018. This system uses a density-based system to reduce traffic congestion and unwanted long-time delays during traffic light switchovers, especially when traffic is light, by analyzing the counting and controlling system using IR technology and an 89C52 microcontroller. The traffic lights are controlled automatically by an algorithm based on the RF switch/key pressed by the ambulance driver while in range. Every patient in the monitoring system is given an RFID TAG/smart card that contains all the patient's information, such as name, age, sex, major diseases suffered, medical history, and so on. When the RFID TAG/smart card is swiped on an RFID reader (installed in the ambulance), the information is transferred to the hospital department using GSM technology (Bhatia et al., 2018). The concept behind (Bharade et al., 2017) is that anytime an ambulance comes to a standstill due to traffic congestion on its approach to the hospital, the RFID reader located at the traffic light scans the RFID-tagged ambulance and communicates its data to the microcontroller.

The suggested system in this research (Bhajantri et al., 2019) offered a proposal for an emergency patient transportation monitoring system. During the critical hour of patient transportation, continuous monitoring of ambulance location and status helps to enhance medical treatment. As a result, a quick, cost-effective, and efficient traffic management system is required. It may show the position of the ambulance as well as the patient's heart rate and temperature. The proposed system also keeps track of a patient's past prescription history, which will aid in improved treatment. The data of the patient can be retrieved using a biometric device that will be available in ambulances (Fadel et al., 2020).

Corradini and Gheorghiasa (2015) proposed a video streaming solution that promotes conversations between ambulance paramedics and the doctor in the emergency car in another paper done in Denmark, by including a 4G camera with an assigned phone number as part of each ambulance's equipment. In this method, a doctor in an emergency vehicle may simply phone the number of the camera linked with the ambulance to which he or she was dispatched (Corradini & Gheorghiasa, 2015).

Comparative Analysis

Different approaches were discussed to reach the same purpose, which is to deliver the patient to the hospital as fast and safely as possible. Some writers suggested implementing a traffic management system, by using RFID in the traffic lights to switch the light to green when it detects an ambulance. Meanwhile using google maps to suggest the shortest path possible to the patient.

Other writers suggested monitoring the patients' conditions, treating them, and getting their information before they arrive at the hospital, by using sensors connected via 5G with the cloud server of the hospital, to detect the biomedical status of the patients and share them with the intended hospital. Others suggested using cameras to help the doctors in monitoring the patient's status while they are on their way to the hospital.

If a patient requires an ambulance, the system detects and dispatches the nearest ambulance. After speaking with the patient, the expert examines the situation and locates the best available hospital using the specified technique. However, another Malaysian initiative proposed a Smart Ambulance Traffic Regulation System, which is an integrated system of traffic light control for emergency ambulance services. Radio-Frequency Identification (RFID) is used to communicate with traffic lights during traffic congestion. For RFID readers to be recognized and traffic light operation to be regulated at approaching traffic signal intersections, the emergency ambulance driver must activate the RFID tag. Furthermore, in Saudi Arabia, a solution was built to

locate an accident on the road network and the nearest ambulance to the event location. It also calculates the quickest route from the closest ambulance to the accident scene, and then to the nearest hospital. The quickest path on both main and minor roads is built to avoid traffic congestion during peak hours. Research in India proposed an application that would allow users to request an ambulance with a single tap and monitor it using GPS on their smartphone. They also employed RFID technology to guarantee that the ambulance arrives on time. In another study conducted in India in 2020, Arduino Uno has been upgraded to Arduino Mega Board, as Mega has a flash memory of 256kb compared to 32kb on Uno, which is sufficient to save patient vital signs while detecting the status of traffic lights present in various paths. The patient's vital signs are also sent to the destination hospital so that the medical staff can deal with the situation. According to the researchers, emergency vehicles would be less crowded and will get to their destinations faster using this technology.

Traffic Controlling Approach

In a study published in 2008, an intelligent traffic control system was proposed. Each road junction has four lanes and four traffic lights. An RFID reader and a controller unit are included with each transmission. When an ambulance comes within range of the traffic signal's RFID reader, the RFID reader scans the ambulance's RFID tag, and the control unit automatically turns that light to green while all other signals in the circle remain red. Arduino, RFID Reader, LED(Light Emitting Diode), LCD(Liquid Crystal Display), and power supply were included in the proposed project. When the Arduino and RFID reader is powered, the Arduino and RFID reader delivers electricity to the LED and LCD. The three LED kinds utilized are RED, YELLOW, and GREEN. When an RFID reader detects an RFID tag connected to an ambulance, it communicates the data contained in the tag to Arduino, which then checks the priority of the vehicle before turning on the Green LED of the relevant lane for a certain period. Arduino resumes regular functionality when the set time has passed. When an RFID tag is scanned by an RFID reader, the procedure is repeated.

However, in 2016 another paper discussed an ambulance management system (AMS) architecture for traffic control, which is a solution that utilizes ArcGIS9.1, GPS, and GSM. A GPS receiver is mounted in each ambulance to establish its real-time position (x, y coordinates) based on the signal supplied by satellite, and this information is transferred to the emergency hospital via a GSM modem. Data like route maps, directions, and voice messages can be sent over the GSM network. Each ambulance is also equipped with a computer or a personal digital assistant (PDA) that displays the route calculated by the AMS in the emergency room. When a call comes from the accident site to the traffic control room, the controller informs this information to the nearest emergency hospital, police station, and fire station (if any fire occurs on the spot). Emergency hospitals will use an Ambulance management system (AMS) to find the accident site on the road network (nearest road segment and landmark) and find the nearest ambulance to the accident site and allocate that ambulance to the accident site. AMS tools are used to find the fastest path from the nearest ambulance location to the accident site; from the accident site to the nearest hospital; a route map and directions are sent to the ambulance driver. In addition, another article from 2021 suggested using an RFID Transmitter (Tx) in an ambulance to transmit a signal to an RFID receiver (Rx) at the next impending traffic lights junction. Once the signal is received at the traffic light junction, the Near Field Communication (NFC) module and microcontroller will do a fast check to determine the route of the approaching ambulance, and if the ambulance is in the red lane, they will stop the present flow of traffic. The traffic lights along the ambulance path will thereafter be turned green by traffic control. It distinguishes out for its offline capabilities and the fact that it does not require the use of a server. Because the proposed SATCS(satellite communication service) is based on RFID technology, it is less expensive to install than equivalent current systems. Another study, on the other hand, employed cloud computing to store both RFID and app data. It also provides access to the cloud whenever needed. The data from the RFID and app is also delivered to the microcontroller, which processes it and changes the signal accordingly. In addition, another research in 2019 recommended that an ambulance smartphone application be developed and utilized to relay ambulance position data to a cloud server. They created the acoustic interface between the ambulance and the smartphone that was mounted on the ambulance's dashboard. When a siren rings, the ambulance smartphone application sends the location of the ambulance to a cloud server. The cloud server application, on the other hand, distributes ambulance position information to other general vehicles while meeting the requirements that the ambulance travels on a major road, the distance between the general vehicle and the ambulance is less than 500 meters, and the general vehicle and ambulance are in proximity.

Registration Method

The methods for registering for this ambulance management and patient monitoring systems vary; some articles advised that users utilize a mobile application. A study from 2008 proposed the High Priority Vehicle Booking Application. When a user loads a page, a socket connection is formed between the user and the server for communication purposes. When the user needs an ambulance, he or she will request one by pressing the Get Ambulance button. This button sends the user's created ID as well as the user's current location to the server. The Google Maps API is used to extract the supplied location.

Other papers, on the other hand, used a different registration method. According to a report published in 2016, registration would begin when an accident site calls the traffic control center, and the controller informs the nearest emergency hospital of the information. Ambulance management systems (AMS) will be used by emergency hospitals to locate the accident location on the road network, locate the closest ambulance to the accident site, and assign that ambulance to the accident site. Other systems, for example, just regulate traffic without dispatching ambulances to patients. However, in certain situations, the patient's information is scanned automatically. According to research published in 2018, a patient's RFID TAG may be swiped on a scanner, which sends the patient's details, such as name, age, ailment, and so on, to the hospital department via GSM technology. Similarly, in another paper in 2019, the patient with critical situations such as cardiac stroke patients are being monitored via senses to detect their situation, and whenever the patient's heartbeat rate changes badly, the Arduino which records all the patient's information uses GSM shield to send an SMS message containing this information, patient ID and the location of the patient which has been taken via GPS shield, to his doctor's mobile phone, who in turns sends an ambulance to the patient's location. and in certain cases, the patient's information is already saved in the country's health database, and all the information, including his name, ID, and medical history, can be accessed simply by scanning his fingerprint while they are rescuing him in the ambulance (If the patient had a car accident for example and didn't call the ambulance).

Biomedical Sensors

Other authors proposed using telemedicine to keep the patient's condition stable while transporting him to the hospital. In 2019, a paper proposed a similar approach in which the injured individual's body condition is fetched through a sensor, and this device is used to avoid lateral arrangements in the hospital for treatment until the ambulance arrives, as well as informing the doctor and the injured patient's family about the accident. It makes use of an Arduino Uno that is connected to a computer through USB. The heartbeat sensor is connected to the microcontroller to measure BPM (Beats per Minute rate), the ECG sensor collects the electrical signals generated by the heart, the temperature sensor is used to quantify the temperature in blood vessels and estimate the cardiac output, and the fingerprint scanner scans and retrieves a person's fingerprint for security purposes. The fingerprint is used to acquire the victim's personal information.

Another study in India used the method of monitoring and tracking not just the patient's vital signs, but also important activities, physical and mental status, and drugs. In this article, WBAN is used to track and access data from patients (a network of heterogeneous sensors connected to a hub). Each ambulance is a node in the wireless network, which is connected through the internet to a centralized hospital server situated at a specific hospital. Similarly, numerous ambulances from the same hospital relay patient data to the same hospital's server. In contrast, the DHT11 Sensor was employed to measure body temperature in a report published in 2020. The measured temperature is sent serially to the controller. The NSK TCRT1000 heart rate sensor is used to measure heart rate. Photoplethysmography is the basis for its operation. A light detector and a light source are arranged on the same side of the sensor for measuring purposes. The finger is then moved to the opposite side. Following that, the light source emits light that passes through the patient's finger, and the light reflected is detected by the light detector within the sensor. The quantity of light reflected by the finger changes with the amount of blood flow induced by the heart pounding. Another research published in 2017 recommended utilizing Arduino, Raspberry Pi, a pulse rate sensor, a temperature sensor, and jumper wires to create a smart band that would sense the patient's biological status. The temperature sensor and the pulse rate sensor are linked to Arduino's Analog pins (A0 and A1). Using a serial USB converter, Arduino is linked to the Raspberry Pi.

Video Streaming Feature

In a paper published in 2015, the hardware for the enabling video streaming technique consisted of the Raspberry Pi B, which is a credit-card-sized single-board computer based on the Broadcom BCM2835 system on a chip. It also includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, with 512 MB, a 15-pin MIPI camera interface, HDMI, and RCA for video in, a 640x350 to 1920x1200 resolution for video out, and

digital HDMI for audio. They also relied on the 3G/4G network for connectivity since they were the latest technology back then when the paper was issued. However, in 2018 another paper suggested using a small cell base station (HeNB) instead of the 4G network, which is located inside the ambulance.

A transceiver should be installed on the roof of the ambulance to transmit/receive data to/from the backhaul microcell network. The HeNB installed inside the ambulance makes a wireless connection between the paramedics and the small cell access point (SAP). The SAP and the transceiver are connected through the wired network. But nowadays with the development of the 5G network, with its special characteristics of reliability and high frequency of transferring a large amount of data in a matter of milliseconds, the use of video streaming would be much more popular. In a paper conducted in 2021, a 5G-enabled smart ambulance system was proposed with its ability to establish a 5G communication network, remote video communication and telemedicine medical data exchange. The approach uses VR glasses, or video terminals, in real-time, to grasp the condition of patients in transit. Emergency and critical patients can immediately receive expert rescue guidance.

System Conceptual Design

The Proposed System Architecture

The proposed system mainly consists of five main elements, the mobile application that all citizens can use to register for this service, the hospital server in the cloud in which all the patient's data would be stored, the doctor's, and the receptionist's system in corporation with the emergency department, and lastly the ambulance IoT sensors that sends the patient's data in real-time to the hospital server. The hospital system shares and forward the data and information of the citizen to the doctors and paramedics via the 5G network. As shown in Figure 1.

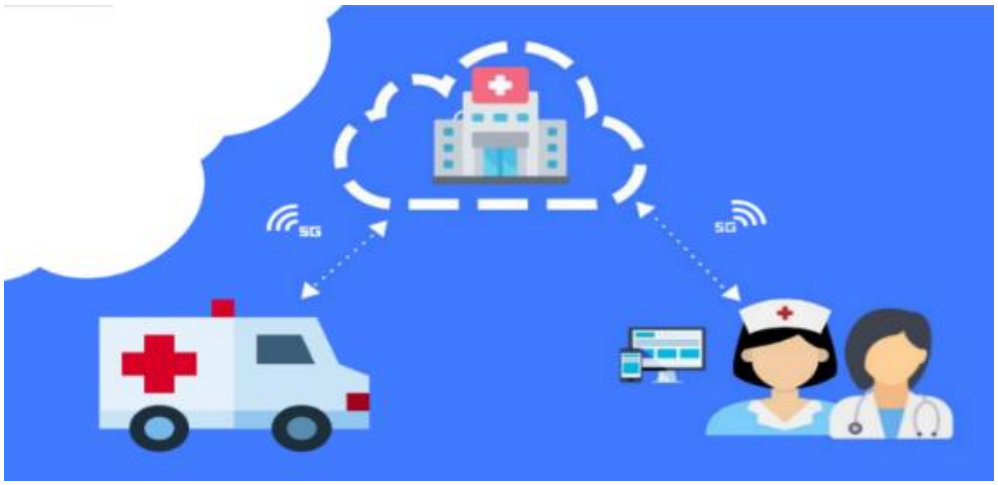

Figure 1. Shows general system view

The Patient Registration Mobile Application

Since in Libya, there is no electronic health record, there is no way to retrieve the patient health history base on his ID or national number as known in most developed countries. In this case, a mobile application is used so the patient can register himself and his family members, the user taps on the register, and fill in the fields with the necessary information such as the person's national number, name, gender, birth date, location, phone number, profile picture, blood group, and a relative's name and phone number in case of emergency, past medical history for example if they suffer from allergy or any chronic disease, and family history in case they have any common disease in their family. All this information would be directly stored in the hospital server and can be used as a mini health record in case of an emergency. The mobile application can be used to register multiple patients, in case the father downloads the application he can register his kid's information.

In case the user needs to call an ambulance, he can open the application and tap on the call ambulance, then a list of the hospital subscribed to this service would be displayed, prioritized by their closeness to the patient's

address, he can choose the nearest hospital or the hospital they prefer. In case the patient needs to change his location manually he can change his location in the request before the submission is done, otherwise, his current location would be sent to the hospital by GPS, then he submits the request.

The Receptionist Ambulance Management System

On the other hand, with the emergency room system, when the receptionist at the institution receives the request, strictly at the targeted hospital, the system displays the patient's location and name. The receptionist clicks on send ambulance button beside the patient information. The system then displays the ambulances list with their IDs and driver's name and phone number.

The receptionist then can review the patient's information then request a doctor could be done, by doctors' names, specializations, and phone numbers would be displayed, the receptionist should choose a doctor and click on the request to assign this particular patient to this doctor, and the patient's information is then sent to this doctor's application. As shown in figure 4.10. Also, the receptionist would start the admission procedure, and allocate a room for this patient, from the allocated room, just after the doctor decides the patient's condition severity level if he needs ICU (intensive care unit) or CCU (cardiac care unit) or Word unit.

The Integrated Rescue System in the Ambulance

Meanwhile, in the ambulance, the patient location and phone number of this particular request or call would be displayed on the ambulance driver application, so the driver can use google maps to display the shortest route to this destination. When the ambulance arrives at the patient's address, and the patient is carried in the ambulance, the paramedics attach the wireless body sensors to his body so that they start to detect his biological conditions, heart rate, blood pressure, oxygen levels, etc. as shown in Figure 2, and the paramedics would start treating the patient. The monitor that is connected to the system in the ambulance would display the patient's information. In case, the patient has bled the paramedics can use the Bank of blood local service to request blood for this patient blood group since in Libya we have ashortage of blood packages in hospitals, and this mobile application service can be helpful.

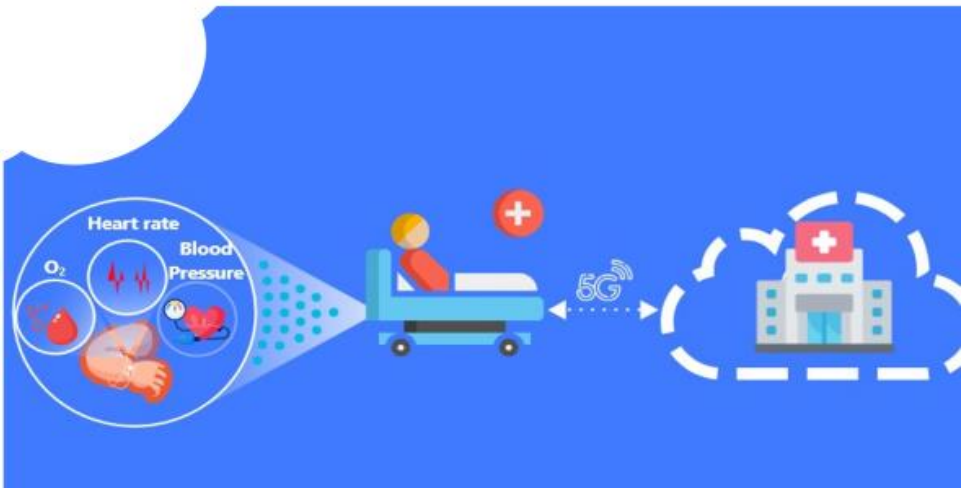

Figure 2. Body sensors sending real-time data to hospital via 5G

The Patient Monitoring and Tele-Diagnose System

On the doctor's side, the patient information would be displayed after the receptionist forwards the request and the information to this doctor. A real-time connection with the ambulance's system would be established, and the biological readings and vital signs of the patient would be displayed on the doctor's desktop or mobile application. The doctor can start diagnosing the patient and type the primitive diagnosis in the diagnosis text field, and then chooses from the list displayed choices if the patient needs to enter the ICU, CCU, or Word unit, depending on the patient's condition seriousness level. The receptionist receives what type of room the doctor has chosen and then allocates this room for the patient, and by that, the admission procedure is automatically

finished. The doctor can call the paramedics through the ambulance system attached to the ambulance equipped with a microphone, speakers, and a camera, in case video streaming is needed. This connection is done by the 5G technology for its reliability, and in case the 5G network is not available a connection established through SMS can be maintained as an alternative.

Survey Results and Analysis

Moreover, people's reactions and thoughts were collected about the proposed system throw a survey. The survey's main purpose was to gather data about how local citizens feel about the traditional ambulance service in their country, and if they have ever used the service, as well as if the smart ambulance system was implemented in the real world would they change their mind and start using the system. The survey aims to gather data about the level of satisfaction of the population with the traditional and the proposed ambulance to measure the effectiveness of the proposed system.

The survey was open publicly to anyone; the responses are 224 responses in total, all Libyans. People from different specializations fill out the survey, including human medicine, information technology specialists, rescue services, and more. The method of data collection used was an electronic questionnaire powered by Google. The link to the questionnaire was shared publicly on different social media platforms, and a QR code was generated and shared with the medical and information technology students and teachers. More than half of the responses (59.2%) were from human medicine, 19.4% from information technology specialists, 2.2% from rescue services, and the rest are specialists in engineering, dentistry, economy, and public health.

The survey first asked the applicants if they have ever experienced an emergency case either by themselves or their family members and if they have ever called an ambulance when the situation occurred. Based on this answer they were two different sections one for the people who had called the ambulance, and the other for those who have never called the ambulance.

The first question related to the people's experience with the ambulance was," have you or one of your family members ever entered the emergency department in the hospital", 69.5% answered yes, and 30.5% answered no. The percentage of people who have never used an ambulance is considerably high, which indicates a serious problem. The survey also asked why they didn't call the ambulance when they needed it, 38.9% said they don't trust the service responsiveness and the speed of the ambulance arrival. They chose "I don't trust the speed of the ambulance and their response", 38.4% chose '' Nothing happened to me that required me to call an ambulance'', and 18.2% said that they prefer to rescue their family members using their cars. The other 4.5% said the service was not available. The negative responses were much more than the positive responses, which indicates a problem. An investigation of this problem can be done after reviewing the data that the applicants submitted when answering about their trust in the current service.

The survey asked the audience if they trust the ambulance service in their countries, and why they trust or do not trust it. Around 153 responses out of 185 respondents said that they don't trust the ambulance services in their country, and 22 respondents answered that they do trust the service. The rest 10 answered that they don't know if there is an ambulance service in their country (Libya). The reason why they don't trust the ambulance services vary between the response time and the lack of technical support given to this section by the country, as well as the traffic on the road and the bad experiences they have seen or heard related to the service. Some others wrote that they use private rescue companies to request an ambulance, and a considerable number of applicants said that they don't even know the service number.

The Applicants' Experience with the Ambulance

This section had 6 questions and the first question asked whether the ambulance arrived at the right time. Most answered that they don't know or remember whether it arrived at the right time or not. The same answer appeared when asked about the patient's condition when he arrived at the hospital, whether he was transported safely, and if the ambulance got to the hospital at the right time. The other 2 questions were ''Did you face the problem of the patient's blood type deficiency in the hospital?'', and ''Will you repeat your experience of calling an ambulance in case of another emergency?'' When asked about blood deficiency, the answers were equal, 50% said yes, they had the problem of blood deficiency, and the other 50% said no they have not faced the problem.

People's Satisfaction with the Proposed System

The last section was about gathering the applicants' feedback on the proposed system. The survey contained a video describing the basic aspects of the system. Since the survey was open to the public, the video had only the most basic aspects with a non-technical description of the system. As shown in Figure 3, Several questions asked for the people's opinion on the system. Out of 224 applicants, 144 said excellent, 53 said very good, 24 answered good, 2 said poor, and 1 said very poorly. It can be concluded that the positive feedback was much higher than the negative feedback. Other questions were asked "Do you think this project can be implemented in your country?", and the result was 44.2% says maybe and 49.1 says yes were the rest disagreed with this question.

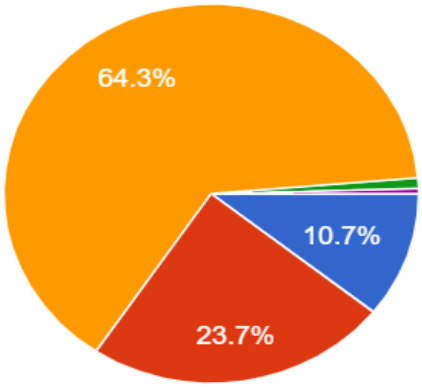

Figure 3. The percentage of the answers to the question "what is your opinion about the proposed system?"

Conclusion

The problem of the patient's delay to get treatment is a serious problem that may lead to the patient's severity or death. The literature of this paper overviews a set of proposed computer systems those help to provide solutions for such a problem. A conceptual design of the smart ambulance system was proposed, the design consisted of four parts, a patient registration mobile application in which patients can register their data and request an ambulance from the nearest hospital; the receptionist ambulance management system, which manages registered patients' data, stores their data as a mini health record, assigns each patient to a doctor, manages the ambulance requests, and sends the ambulance to the patient; the integrated rescue system in the ambulance, which consists of sensors that measure the patients' data and send it to the hospital in real-time by 5G technology; and the system requests blood from the Bank of blood by Almadar; and the patient monitoring and tele-diagnosing system in which doctors can monitor and diagnose the patient's condition.

A survey was conducted electronically to measure the people's satisfaction level with the current ambulance service, and the proposed system, and to gather their suggestions to improve the idea. An animated video that explains the system was created and involved in the survey, so people can understand the system clearly. The survey was opened to the public and shared through links on social media sites and for local university students to fill out.

The results of the survey have revealed the lack of trust in the current ambulance services, the people's independence in rescuing their patients, and the people's acceptance of the idea of solving the problem. The positive answers to the proposed solution have the majority of answers, most respondents liked and welcomed the idea, some had really good suggestions, and few people did not believe in the system's vision. According to the obtained results, it can be concluded that the proposed system would increase the population's trust in the ambulance services if applied, people's belief in the system's ability to solve common rescuing problems, and people's willingness to rely on such systems to rescue their loved ones.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

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